Section A

For each question, there are four possible answers **A, B, C,** and **D**. Choose the **one** you consider to be correct.

1 When 10.0 cm^3 of a 0.10 mol dm^{-3} solution of alkali metal salt MXO_3 was reduced with an excess of acidified potassium iodide solution, the resulting iodine required 60.0 cm^3 of 0.10 mol dm^{-3} sodium thiosulfate solution for its reduction. The anion could be reduced to

A XO_2

B XO^{2-}

C XO^-

D X^-

2 *The use of Data Booklet is relevant to this question.*

The successive ionization energies, in kJ mol^{-1}, of an element **X** are given below.

870 1800 3000 3600 5800 7000 13200

What is **X**?

A $_{33}As$

B $_{53}I$

C $_{8}O$

D $_{52}Te$

3 Which of the following is a redox reaction?

A AlH_3 (g) + H^- (g) → AlH_4^-

B Al^{3+} (aq) + $3OH^-$ (aq) → $Al(OH)_3$ (s)

C 2 Al (s) + $3Cl_2$ (g) → $2AlCl_3$ (s)

D AlO_2^- (aq) + H^+ (aq) + H_2O (l) → $Al(OH)_3$ (s)

4 10 cm^3 of a hydrocarbon was mixed with 100 cm^3 of oxygen gas which is in excess. The mixture was exploded and after it was cooled to room temperature, the residual gases occupied a volume of 80 cm^3. Upon passing the gases through potassium hydroxide, this volume decreased to 50 cm^3. What is the formula of the unknown hydrocarbon?

A C_3H_6

B C_3H_8

C C_4H_8

D C_4H_{10}

5 A sample of 0.025 mol of the chloride of an element Z was dissolved in distilled water and the solution made up to 500cm^3. 12.5 cm^3 of this solution reacted with 25 cm^3 of 0.1 mol dm^{-3} silver nitrate solution. What is the most likely formula of the chloride?

A Z_2Cl

B ZCl

C ZCl_2

D ZCl_4

6 Consider the following four compounds:

(I) $(CH_3)_3CH$
(II) $CH_3CH_2CH_2OH$
(III) $CH_3CH_2CH_2SH$
(IV) $CH_3CH_2CH_2CH_3$

What is the order of the increasing boiling point of the compounds?

A I, IV, III, II

B II, III, IV, I

C III, II, IV, I

D IV, I, II, III

7 $AlCl_3$ reacts with $LiAlH_4$ and $(CH_3)_3N$ to give $(CH_3)_3NAlH_3$. Which one of the following will be true of $(CH_3)_3NAlH_3$?

A The Al atom is tetrahedrally coordinated.

B The Al atom is electron deficient.

C It contains hydrogen bonding.

D It is dimeric.

8 When 13.08g of zinc dust was added to 250 cm^3 of 1.0 mol dm^{-3} aqueous copper (II) sulfate, the temperature of the solution rose by 15°C. The specific heat capacity of the final solution is 4.20 J g^{-1} K^{-1}.

$$Cu^{2+}(aq) + Zn(s) \rightarrow Zn^{2+}(aq) + Cu(s)$$

What is the enthalpy change for the above reaction?

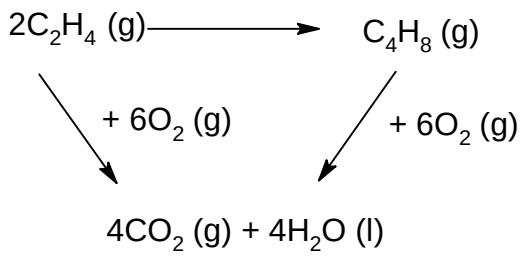
A -82.9 KJ mol^{-1}

B -78.8 KJ mol^{-1}

C -66.3 KJ mol^{-1}

D -4.12 KJ mol^{-1}

9 Given the standard enthalpy change of combustion of but-1-ene and ethane are *p* and *q* KJ mol^{-1} respectively. What is the standard enthalpy change of the reaction $2C_2H_4(g) \rightarrow C_4H_8(g)$?



A $2q - p$ KJ mol^{-1}

B $(p + q)/2$ KJ mol^{-1}

C $q - 2p$ KJ mol^{-1}

D $(q - p)/2$ KJ mol^{-1}

10 The data below refers to the standard molar enthalpy changes of combustion of some members of the alkanes.

Alkane	ΔH_c^{θ}/KJ mol^{-1}
CH_4	-890
C_2H_6	-1560
C_3H_8	-2220
C_4H_{10}	-2880
C_5H_{12}	-3510
C_6H_{14}	-4190

The enthalpy change of combustion of another alkane **X** has a standard enthalpy change of combustion of -6780 KJ mol^{-1}. The formula of **X** is likely to be

A C_9H_{20}

B $C_{10}H_{22}$

C $C_{11}H_{24}$

D $C_{12}H_{26}$

11 The data below refers to the radii and charges of six ions.

Ion	P^{2+}	Q^{+}	R^{+}	T^{2-}	U^{-}	V^{-}
Radius/nm	0.16	0.19	0.15	0.16	0.19	0.15

PT, QU and RV are ionic solids of the same lattice structure. Which one of the following gives the correct order of their lattice energies with the lowest numerical value first?

A QU PT RV

B PT QU RV

C PT RV QU

D QU RV PT

12 In the presence of ultraviolet light, the "inert" xenon gas will react with fluorine gas to produce XeF_4 according to the equation,

$$Xe\ (g) + 2\ F_2\ (g) \rightleftharpoons XeF_4\ (s)$$

What is the correct equilibrium constant K_c?

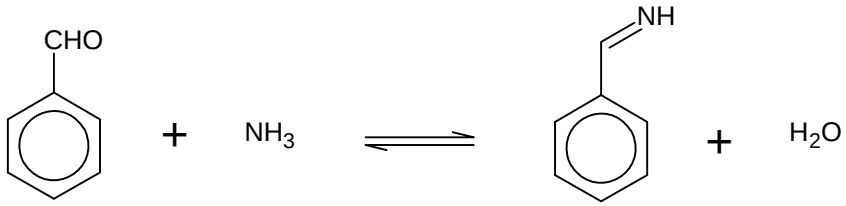
A $\dfrac{[Xe][F_2]}{[XeF_4]}$

B $\dfrac{[XeF_4]}{[Xe][F_2]}$

C $\dfrac{[XeF_4]}{[Xe][F_2]^2}$

D $\dfrac{1}{[Xe][F_2]^2}$

13 Consider the following reaction scheme involving benzaldehyde and ammonia in methanol to form an imine.



Which of the following statement is true?

A The rate of the forward reaction is faster than the backward reaction.

B The forward reaction is favored by the addition of ammonia.

C The backward reaction is favored by the addition of benzaldehyde.

D The value of K_c increases with the addition of ammonia.

14 Which one of the following gives the correct definition of an acid according to the Bronsted-Lowry theory?

A It dissociates in water to give $H^+(aq)$ ions.

B It is a proton donor.

C It is a proton acceptor.

D It is an electron donor.

15 What is the pH of the final solution formed by mixing equal volumes of two separate portions of dilute sulfuric acid of pH 2.0 and pH 4.0?

A 2.3

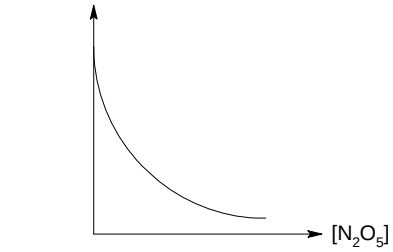
B 2.6

C 3.0

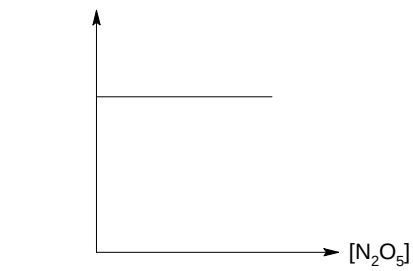
D 3.6

16 The decomposition of dinitrogen pentoxide N_2O_5 was found to be first order with respect to the concentration of N_2O_5. Which one of the following graphs confirms the results?

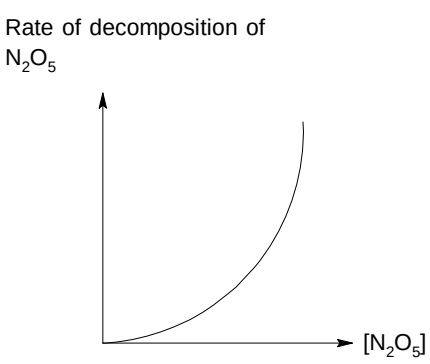
A



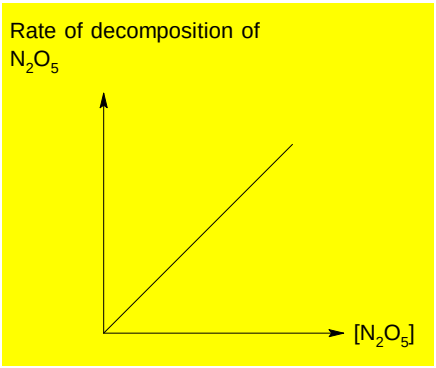
B



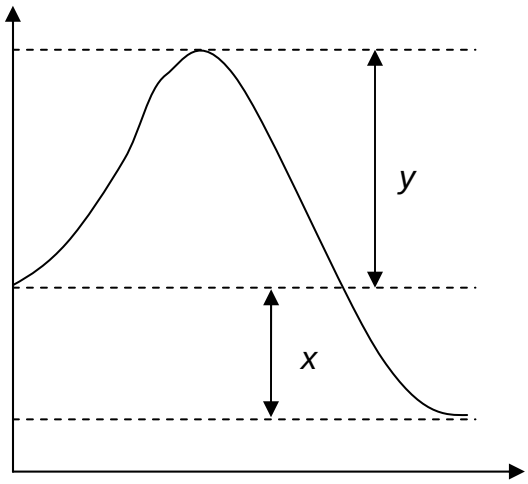
C



D



17 An energy diagram is shown below.



What is the activation energy of the **reverse** reaction?

A *x*

B *y*

C (*x*+*y*)

D (*y*-*x*)

18 The reduction of a nitrile produced a compound of formula $C_3H_7NH_2$. Which of the following would be produced if the same nitrile was heated with hydrochloric acid?

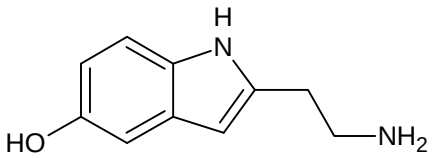
A CH_3CONH_2

B CH_3CH_2OH

C CH_3CH_2COOH

D $(CH_3)_2CHCOOH$

19 **Serotonin** is a monoamine neurotransmitter.



Serotonin

How many sigma (σ) and pi (π) bonds does **serotonin** have?

A 26σ and 2π

B 26σ and 4π

C 28σ and 2π

D 28σ and 4π

20 Which one of the following, in alcoholic solution, produces a precipitate most rapidly when warmed with aqueous silver nitrate?

A 1-chlorobutane

B 1-bromobutane

C 1-iodobutane

D chlorobenzene

21 Consider the four compounds below:

CH_3CO_2H	CH_3CH_2OH	CH_2FCO_2H	CHF_2CO_2H
I	II	III	IV

Which of the following sequence arrange the compounds in increasing pH for their aqueous solutions?

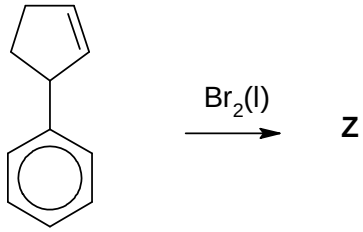
A II, IV, III, I

B IV, III, I, II

C II, I, III, IV

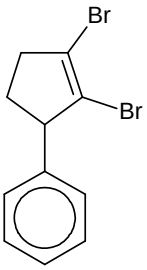
D I, III, IV, II

22 A student attempts to synthesis compound **Z** from the following synthetic route.

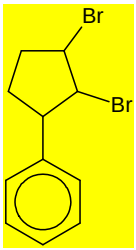


What is compound **Z** that is formed in this reaction?

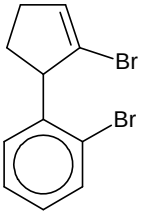
A



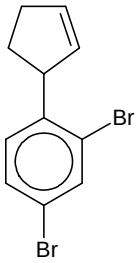
B



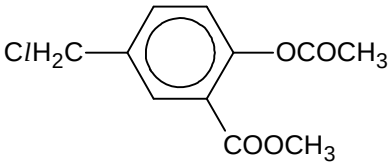
C



D

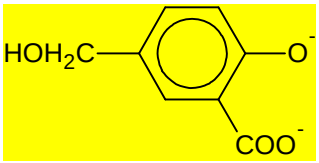


23 Which one of the following represents the organic ion produced when an excess of hot aqueous sodium hydroxide is added to compound **P**?

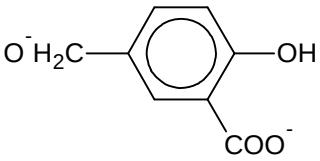


P

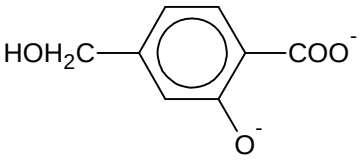
A



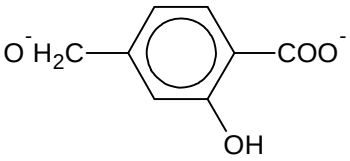
B



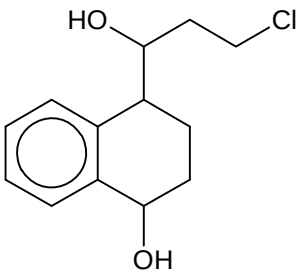
C



D



24 What is the total number of possible of geometric isomers that can be formed when the following compound reacts with excess concentrated H_2SO_4?



A 2

B 4

C 6

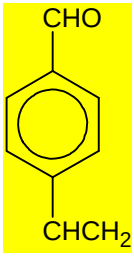
D 8

25 Compound **Q** was subjected to the following tests and the results were recorded below.

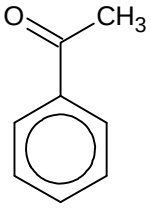
Reagents and Conditions	Observations
Acidified $KMnO_4$, warm	Purple solution turns colorless with CO_2 evolved.
Fehling's reagent, warm	No precipitate observed
Tollen's reagent, warm	Silver Mirror observed

Which of the following could be **Q**?

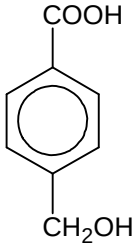
A



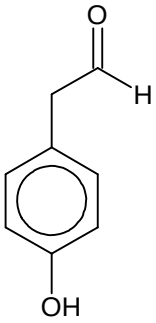
B



C



D



Section B

For each question, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements which you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

26 Which of the following particles would, on losing an electron have a half-filled set of p orbitals?

1 N^-

2 C^-

3 O^+

27 Which of the following systems contain delocalised electrons?

1 Cyclohexene

2 Graphite

3 Sodium

28 Which oxide has a molecular structure?

1 Al_2O_3

2 Cl_2O_7

3 P_2O_5

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

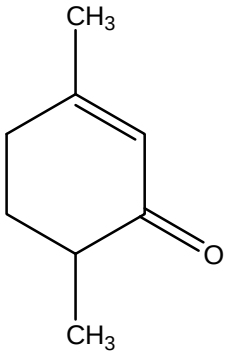
29 In which of the following reaction(s) does the underlined reagent provide an electrophile for the reaction indicated?

1 $\underline{HBr} + CH_2{=}CH_2 \rightarrow CH_3CH_2Br$

2 $\underline{HCN} + CH_3COCH_3 \rightarrow CH_3C(OH)CNCH_3$

3 $\underline{NaOH} + CH_3CHCl CH_3 \rightarrow CH_3CH(OH)CH_3 + NaCl$

30 Which of the following statement(s) is/are true about the product obtained when piperitone is heated with hydrogen gas in the presence of nickel catalyst?



piperitone

1 It reacts with sodium metal.

2 It reacts with acidified potassium manganate(VII).

3 It reacts with 2,4-dinitrophenylhydrazine.

Key:

1	D	11	D
2	D	12	D
3	C	13	B
4	B	14	B
5	D	15	A
6	A	16	D
7	A	17	A
8	B	18	C
9	A	19	B
10	B	20	C

21	C
22	B
23	A
24	B
25	A
26	D
27	C
28	C
29	D
30	B